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ABSTRACT

"Levels of processing" is an explanatory framework postulating that differences in memory processing quality or effort affect the duration of the memory trace. Using recall (immediate, one week, or two week) for connected discourse processed under three semantic and three orthographic interference conditions, as well as a noninterference control condition, hypotheses of superior delayed recall for semantic processing conditions and "reversals" from immediate to delayed recall were tested. Subjects were 243 college students. The results were consistent with a semantic elaboration notion (that more difficult tasks require more elaborate processing) but the reversals suggested by other studies were not found to be statistically reliable. (Author/FL)

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Effects of Semantic and Orthographic Interference on Prose Recall

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Levels of processing is an explanatory framework which postulates that differences in memorial processing quality and/or effort affect the duration of the memory trace. Using recall (immediate, one week, two week) for connected discourse processed under three semantic and three orthographic interference conditions as well as a "normal" control, hypotheses of superior delayed recall for semantic processing conditions and "reversals" from immediate to delayed recall were tested. Results were consistent with a semantic elaboration notion, but the reversals suggested by other studies (e.g., Pellegrino, Siegel & Dhawan) were not found to be statistically reliable. Alternative hypotheses are considered.

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Immediate and delayed memory for prose

following semantic and orthographic interference

Levels of processing (Craik & Lockhart, 1972) is an explanatory framework which postulates that differences in memorial processing quality and/or processing efforts affect the duration of the memory trace. Prose processing quality in the levels of processing framework refers to the idea that encoding superficial representations of print, such as orthography, results in less durable memory traces than "deeper" (or, more "elaborated," see for example, Eysenck, 1979) encoding at a semantic, meaning level (Craik, 1978). Related to effort (usually conceptualized as expended processing effort, e.g., Griffith, 1976; c.f. Hyde, 1973, Kahneman, 1973) in a level of processing framework are the findings of Burton and Bruning (1981), Gotz and Jacoby (1974), and Pellegrino, Siegel and Dhawan (1976) which indicate that the amount of interference occurring during encoding has differential effects on immediate and delayed recall. Specifically, minimal interference when compared to high interference, allows for better performance during immediate recall but results in poorer recall on a delayed measurement (c.f. Morris, Bransford & Franks, 1977). In other words, recall performance "reverses" from immediate to delayed measures. These findings suggest that minimal interference evokes less processing while a high interference condition requires more processing, ultimately resulting in better recall over time (Battig, 1979). The superiority of the minimal interference condition in immediate recall may be related to a verbatim effect which lingers for a brief period of time but disappears by the time of the delayed measure, which more accurately reflects the completeness and permanency of the memory trace.

Specific to reading, a number of studies have demonstrated the positive effects of encouraging a reader to process more deeply by performing semantic elaborations on text material. Andre and Sola (1976) found that subjects primed with paraphrased questions remembered more of what they read than subjects who were primed with verbatim questions. Kane and Anderson's investigation (1978) revealed that subjects who were forced to process more deeply by generating the last word to complete a sentence learned more than subjects who read the already completed sentence. Similarly they demonstrated that subjects who were led to more extensive or more elaborative processing within the sentence completion task recalled more on a delayed recall measure. In each study, subjects were prompted to process more deeply within the semantic domain.

One troublesome aspect for the levels of processing framework has been the inability to delineate what "deeper" processing is (see, for example, Baddley, 1978). Recent explanations (Jacoby & Craik, 1979) of the levels of processing framework view deeper processing as more extensive elaboration which leads to a more complete description of the idea or event in memory. The present study examines this issue by presenting subjects with a variety of interference or orienting conditions during a connected discourse reading task. Our basic purpose is to test the relative effects of high interference conditions represented by semantic orienting tasks versus less interfering physical orienting tasks. Using as a guide the presently available but somewhat inconsistent data generated from levels of processing studies, we have predicted better recall performance under semantic interference conditions, but only on delayed measures of recall.

Under normal conditions reading is considered a semantic processing task. However, the amount of elaboration which occurs can depend upon a number of factors ranging from the reader's purpose to external prompts such as questions or advanced organizers (Reder, 1980). Our study attempts to manipulate the amount of elaborative processing which can occur during reading. The extent of the elaborative processing may be reflected in recall performance in several ways. First, increased semantic elaboration should produce a concomitant increase in recall (Jacoby & Craik, 1979). Second, based on the reversal notion that more difficult tasks force more elaborative processing, we expect that the semantic elaboration effects will become more pronounced over time. In fact, in more immediate measures of recall, we do not expect that forced semantic elaboration will provide readers with any advantage since the amount of interference from the physical orienting tasks is less when compared to the semantic orienting tasks. In the immediate recall condition, normal reading should yield the best recall since it is unencumbered by any interference condition. However, we predict that this initial advantage in the proportionate number of idea units recalled by readers who performed physical orienting tasks will be significantly reduced when compared to the recall of the readers who were forced to elaborate semantically.

Method

Subjects and design

Two hundred and forty-three undergraduate and graduate students were randomly assigned in approximately equal numbers to one of seven reading "conditions" involving three physical orienting tasks, three semantic orienting tasks, and one normal, or noninterference, condition.

Across these conditions a second random assignment was made to distribute but participants equally among three recall conditions immediate (n=72), one week delayed (n=56), and two week delayed (n=66). Unequal sample sizes were a result of participants not returning for the subsequent experimental session.

Materials and procedures

Each participant was presented with a booklet which contained a prose passage and an explanation of the task. The 302 word passage had a readability of 10th grade (Fry, 1972). Fifty-nine target words were chosen using a pattern of approximately every fifth word with only those functioning as nouns, verbs, adjectives, and adverbs targeted. Given this constraint the following modifications were made in the selection criteria when the fifth word was inappropriate: 1) the sixth word was selected first, 2) the fourth was the next choice, and 3) the seventh word was the last choice. This modification accounted for all target word selections. To avoid making the task overly difficult, a final constraint was applied which disallowed the selection of two consecutive four word patterns. This selection process yielded an average deletion pattern of 5.19 words. The seven processing conditions were generated as follows:

Physical tasks

1. Count the number of e's in the target word and write the number over the word.
2. Determine the preceding letter of the alphabet for the beginning letter of the target word and write it over the word.
3. Produce a word or non-word which rhymes with the target word and write it over the word.

Semantic tasks

1. Produce a synonym for the target word and write it over the word.
2. Produce an antonym for the target word and write it over the word.
3. Fill in a cloze blank which provided the initial letter of the word.

Normal reading

A "normal" or no interference group was used as a control. During the appropriate time condition (i.e., immediate, one week delayed, two weeks delayed) all subjects were asked to write out story recalls.

Analysis

The data were analyzed using a 3 (time of recall) X 7 (condition) analysis of variance design for each of the dependent variables of main ideas, details and total idea units. Text and recall analyses were conducted using a discourse analysis procedure which was developed by Taylor (1978) and based on the work of Grimes (1975) and Myer (1975). Inter-rater reliability for the text analysis was .95 and total agreement between the two scores was reached to establish the scoring criteria. A random sample of 25 recall protocols yielded an inter-rater reliability of .93. The Scheffe Method test was utilized for all post hoc comparisons. The required level for statistical significance was .05 throughout.

Results

Table 1 displays the mean number of total idea units recalled by week for each condition. As expected a significant effect for time of recall is present, F (2,222) = 98.68, MSe = 42.99, as well as a significant effect for condition, F (2,222) = 7.97, MSe = 42.99. That memory decays over time (the general effect is present across all conditions) is neither surprising

nor of interest here. As for the condition comparisons the significant differences are largely a result of the high recall, overall, for normal and synonym readers relative to the low recall performance for rhyme condition subjects. These effects were qualified however, by a time of recall by condition interaction effect, F (12,222) = 2.58, MSe = 42.99. This interaction derives from the more gradual decay curve of recall under the cloze condition relative to the other tasks. This effect is most pronounced when normal reading is compared to cloze. Normal readers recall a proportion of .24 total idea units immediately, .06 after one week and .02 after two weeks. Under cloze conditions, readers recall .13, .07, and .04 respectively. It should be noted that while normal reading is superior to the synonym condition which in turn is superior to the cloze condition when measured immediately, after two weeks cloze and synonym are both superior to normal reading (as well as other conditions). As expected no significant differences were found between the low interfering physical conditions and the highest interference semantic conditions and the immediate measurements.

Insert Table 1 Here

Table 2 presents the mean number of main idea units recall by condition and time of measurement. Again significant effects for time of recall, F (2,222) = 63.93, MSe = 6.80, and F (6,222) = 6.00, MSe = 6.80, were observed and as with the presentation of total idea results, the analysis for main idea indicated an interaction effect, F (12,222) = 1.78, MSe = 6.80, which is again the result of the superiority of recall for main ideas under both normal and synonym conditions relative to the cloze condition when measured immediately, versus the superior recall under the cloze condition relative to both synonym and normal (as well as all other conditions) when measured

at one week versus the superiority of recall for both cloze and synonym relative to normal at two weeks.

Insert Table 2 Here

Table 3 displays the mean number of detail idea units recalled. For recall of details there is also a significant effect of both time of recall, F (2,222) = 65.38, MSe = 25.83, and condition, F (6,222) = 6.52, MSe = 25.83. These findings are also qualified by the significant time of recall by condition interaction, F (12,222) = 2.15, MSe = 25.83. As may be seen it is the gradual decline of recall for details under the cloze conditions, relative to the remaining conditions (particularly normal and antonym), which accounts for the interaction. Recall for cloze, in fact, which is only about 40% of normal reader recall when measured immediately, is about 150% of normal reader recall when measured at two weeks. Likewise, recall for details under the synonyn condition moves from about 58% of normal reader recall in the immediate condition, to parity after two weeks.

In comparing details with main ideas it may be seen that detail units do not "hold up" in memory as well as main ideas. For example, after two weeks synonym, cloze and normal readers recall .11, .10 and .06 of main ideas respectively while only .01, .02 and .01 of detail units are recalled respectively.

Discussion

Clearly this investigation mitigates in favor of the involvement of sophisticated processes in prose learning such as spread of encoding (Craik & Tulving, 1975) or transfer features (Finn, 1977-78). The study extends the findings of others (Burton & Bruning, 1980; Gotz & Jacoby, 1974) from serial work and triad presentations to the processing of prose passages. It also conforms to the expectations generated by researchers such as Hyde &

Jenkins, 1969; Schallert, 1976) who have found semantic orienting tasks such as ratings of pleasantness to be superior to orthographic orienting tasks. Moreover, the results of this experiment can be easily related to the large body of mathemagenic (Rothkoph, 1965) research, (see for example, Anderson & Biddle, 1975; Rickards, 1979). In essence this body of research postulates that processing quality affects recall such that those tasks which generate greater degrees of encoding (spread) produce more elaborate memory traces.

These synonym and cloze conditions both reflected the benefit of the extended elaboration generated by the orienting tasks as evidenced by the stability of their recalls over time when compared to the other condition. The cloze condition functioned to ensure that the reader processed the semantic features of the text which allow the successful completion of the cloze blank (Anderson & Kane, 1977; and Finn, 1978-79). That is, correct response to a cloze blank is convincing evidence that the reader processed the critical semantic features in the sentence. By contrast, during normal silent reading, a reader, for any number of reasons (Smith, 1979) may omit the processing of those same semantic features. The synonym condition may have allowed the readers a rehearsal advantage while they were finding the appropriate synonym. Although the readers were not always successful in supplying an exact synonym, the generation of responses with overlapping semantic features with the target word could have provided the rehearsal opportunity to improve the memory trace.

The antonym condition while being a semantic orienting task was also the most interfering task (according to the amount of processing time and the complaints of the participants) yielded results like a physical domain task. It is possible that the degree of difficulty of the task exceeded the tolerance of the participants. Another possibility is that the task of generating a

response which contained conflicting semantic elaborations to the target word caused a competition among memory traces which was exacerbated over time.

The generative effect, recently advocated by Slameka & Graf (1978) provided an alternative to the spread of encoding hypothesis. Using orienting tasks similar to the study reported here in a variety of paradigms (e.g., recognition, free recall, paired-associate), the authors argued persuasively that "the act of generation is really an instance of recall, with the source being semantic memory." While such an argument may logically account for the results of Slameka & Graf it appears problematical in the context of the current study. Focusing on the superior recall performance after two weeks for subjects in the synonym and cloze conditions relative to normal readings, normal readers may be considered to have read only, synonym condition reader to have both read and generated, and cloze condition readers to have generated only. Synonym condition readers, in effect, had a double rehersal of each word (each of the 59 target words were scorable idea units and synonyms are scored as correct responses under the scoring system). The cloze group, on the other hand, averaged roughly 70% correctly completed cloze blanks. On average then the cloze group had no contact with 18 of the 103 scorable idea units. Despite these facts the cloze group performed better than the synonym group when measured at one week and equal to the synonym group when measured at two weeks. Obviously, target word generation itself could not account for these findings. The findings are consistent, however, with a spread of encoding explanation.

A more difficult problem is the findings of Morris, Bransford, and Franks (1977). In an excellent series of experiments Morris et al. used list learning rather than prose which would not permit spread of encoding to occur in the sense it is used here. The work of Morris et al. does provide evidence of dependent measure bias (e.g., if you use rhymes as a test and then test for rhymes, participants perform better than those who were semantically oriented).

Obviously, the recall measure used in this experiment is subject to such a bias in terms of comparing the physical or orthographic conditions to the semantic conditions, but such a bias should not be of importance in comparisons within the two condition types over time.

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Table 1

Mean number of total idea units recalled by condition for immediate, one week, and two week delayed recall

Condition	Week Number *		
	0	1	2
Normal Reading	25.20 (15)	6.75 (12)	2.44 (9)
Counting e's	13.29 (17)	.63 (11)	1.20 (5)
Preceding Letter	11.40 (10)	1.72 (11)	.85 (7)
Rhyme	7.40 (15)	1.22 (9)	1.00 (12)
Synonym	17.75 (12)	5.53 (13)	3.55 (9)
Antonym	13.31 (16)	4.00 (12)	.50 (10)
Cloze	12.85 (14)	7.33 (12)	3.66 (12)

NOTE: Total idea units = 103

*Numbers in parentheses indicate the number of subjects

Table 2

Mean number of main idea units recalled by conditions for immediate, one week, and two week delayed recall

Condition	Week Number *		
	0	1	2
Normal Reading	7.93 (15)	2.41 (12)	1.33 (9)
Counting e's	4.17 (17)	.27 (11)	.40 (5)
Preceding Letter	4.00 (10)	.63 (11)	.85 (7)
Rhyme	3.26 (15)	.77 (9)	.83 (12)
Synonym	7.66 (12)	2.23 (13)	2.44 (9)
Antonym	4.81 (16)	1.41 (12)	.30 (10)
Cloze	5.71 (14)	3.33 (12)	2.33 (12)

NOTE: Total Main Idea Units = 23

* Numbers in parentheses indicate the number of subjects.

Table 3

Mean number of detail idea units recalled by condition for immediate, one week, and two week delayed recall

Condition	Week Number *		
	0	1	2
Normal Reading	17.26 (15)	4.33 (12)	1.11 (9)
Counting e's	9.11 (17)	.36 (11)	.80 (5)
Preceding Letter	7.40 (10)	1.09 (11)	.00 (7)
Rhyme	4.13 (15)	.44 (9)	.16 (12)
Synonym	10.08 (12)	3.30 (13)	1.11 (9)
Antonym	8.50 (16)	2.58 (12)	.20 (10)
Cloze	7.14 (14)	4.00 (12)	1.66 (12)

NOTE: Total Detail Idea Units = 80

*Numbers in parentheses indicate the number of subjects